

# Digestion and Excretion

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## Digestion

### Learning Objectives:

- 1) Identify and describe the structure and function of carbohydrates, protein, lipids and nucleic acids and where they are found in living organisms.
- 2) Explain the importance of nutrition and fitness to the maintenance of homeostasis.

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## The Chemical Foundation of Digestion

- All organisms must have some way to obtain **essential nutrients** - basic raw material required to make their own structures, functions and energy for survival
- heterotrophs (consumers) are dependent on autotrophs for their nutrients while autotrophs use inorganic materials such as water and CO<sub>2</sub>.

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## Essential Nutrients

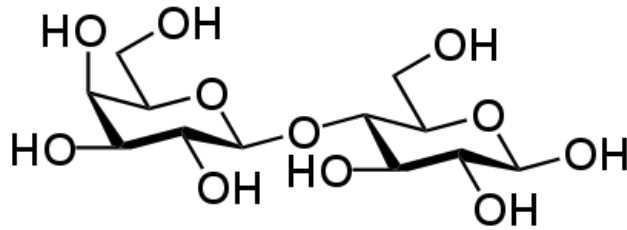
There are six categories of essential nutrients:

- 1) Carbohydrates
- 2) Fats (Lipids)
- 3) Cholesterol
- 4) Proteins
- 5) Minerals
- 6) Vitamins

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## Carbohydrates

Structure - organic compound composed of carbon, hydrogen, and oxygen



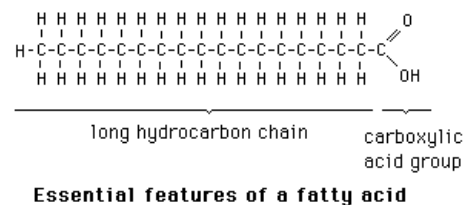
Function - sources of energy that can be accessed quickly

Location - typically stored as glycogen and fat in the human body.

Typical Sources - glucose and starch

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## Fats (Lipids)



Structure - long hydrocarbon chain and a carboxylic acid group

Function - source of energy, insulation (cold and injury), and provide building materials for cell membranes and hormones. When consumed they are broken down into fatty acids and glycerol

Location- typically stored as triglycerides which are associated with muscle fiber.

Typical Sources - nuts, grains, seeds, meat, eggs

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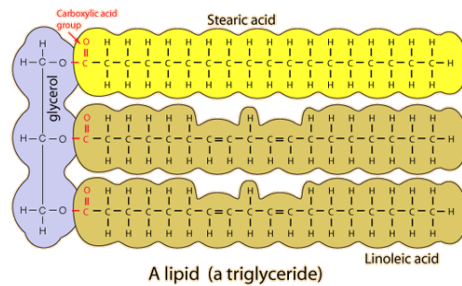
# Cholesterol

Structure - soft waxy lipid

Function - construct cell membranes, insulate nerves, and produce vitamin D, bile acids and hormones. Too much can lead to life-threatening problems

Location - found in body cells and in arteries and veins

Typical Source - meat, whole milk, egg yolks, ...



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# Proteins

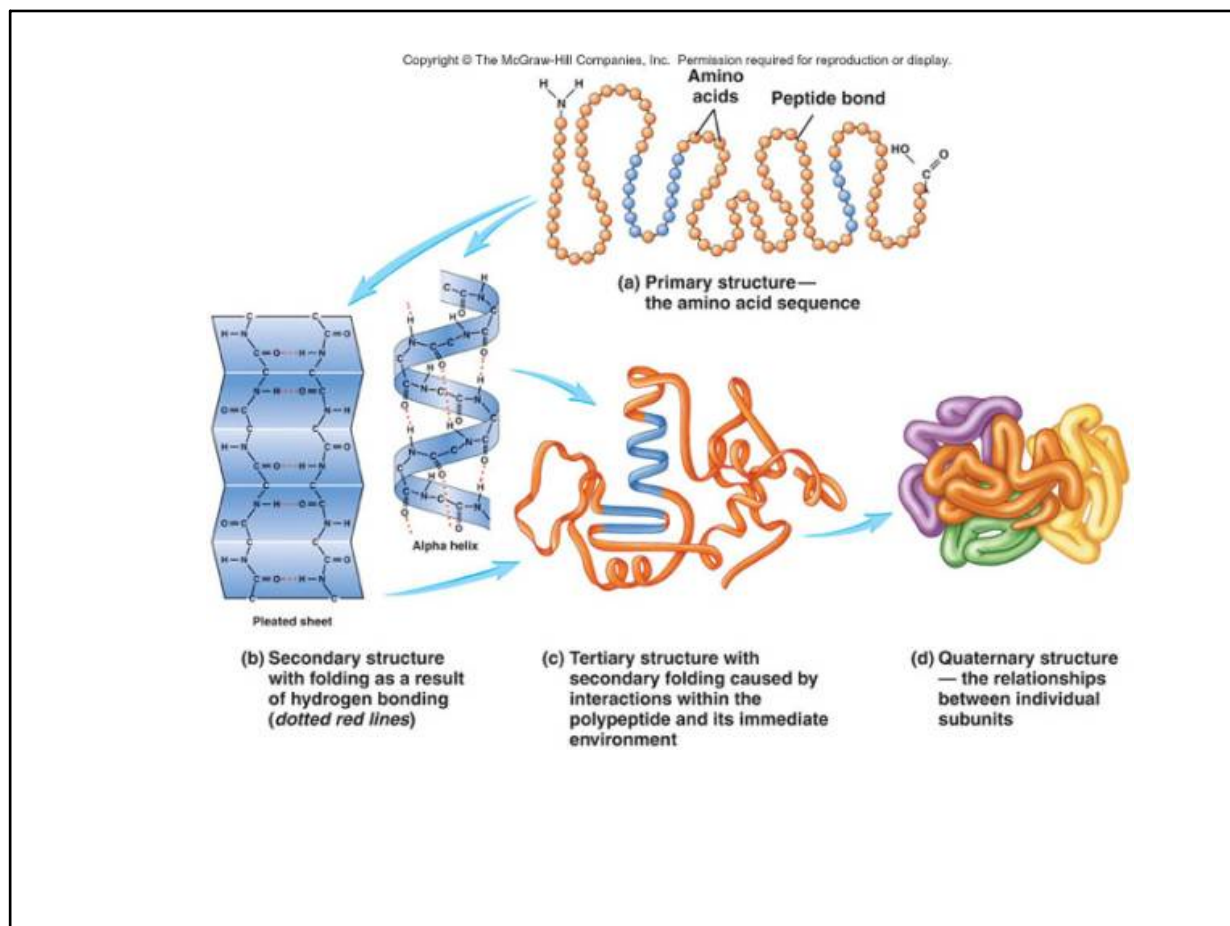
Structure - primary, secondary, tertiary or quaternary

Function - enable metabolic reactions to take place, create antibodies, builds and repairs tissue

Location - entire body (every single cell)

Typical Source - meat, grain products, ...

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## Minerals

Structure - each mineral has its own specific structure

Function - needed in small amounts to help build bones, cartilage, hemoglobin, hormones, enzymes, and vitamins

Location - typically stored in bone and blood

Typical Source - food (each mineral has its own primary source)

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## Vitamins

Structure - each vitamin has its own molecular structure

Function - serve as coenzymes (chemicals needed to make enzymes function), involved in tissue development, and helping the body fight and resist disease.

Location - excess are stored in fat and in the liver

Typical Source - food (each vitamin has a different primary source)

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## Health and the Digestive System

Good nutrition is important for two reasons

- 1) provides energy
- 2) provides essential raw materials (building blocks)

Canada's food guide can help you make healthy food choices especially in terms of the number of suggested servings for each food group.

Individuals who are unable to get sufficient amounts of vitamins and minerals may resort to taking supplements  
- ex. multivitamin pills, herbal supplements, ...

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## Canada's Food Guide

<http://www.has.uwo.ca/hospitality/nutrition/pdf/foodguide.pdf>



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## Learning Objectives:

- 1) Describe the structures, purpose and functioning of the digestive system.
- 2) Identify the major glands of digestion, their secretions and their role in the digestive process.

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## The Two Stages of Digestion

1. Mechanical digestion - physically breaking down food into smaller pieces  
- this occurs in the mouth (teeth)
2. Chemical digestion - separation of food into molecular components  
- begins in the mouth with saliva and ends in the small intestine

On average it takes 24 - 33 hours for each meal you eat to make its passage through your digestive tract.

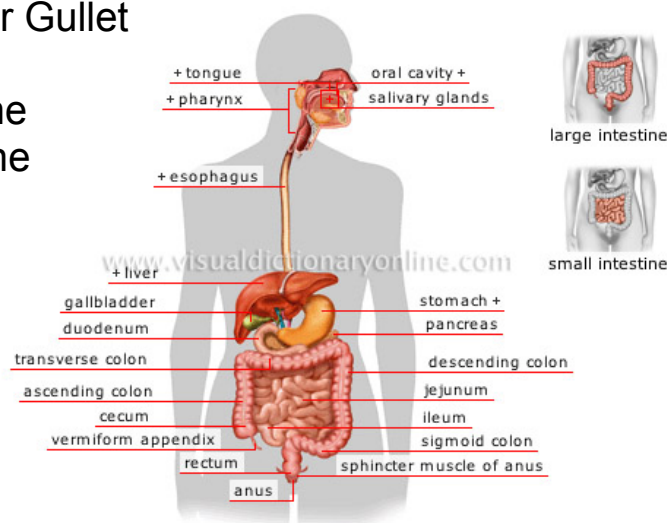
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## The Parts of the Digestive System

1. The Mouth
2. The Esophagus or Gullet
3. The Stomach
4. The Small Intestine
5. The Large Intestine



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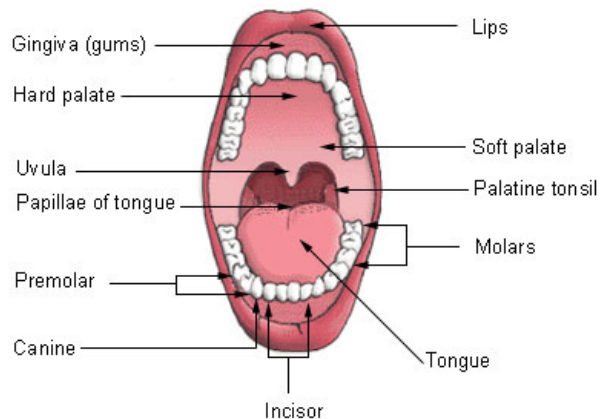


# The Mouth

The part of the mouth:

- **Teeth** - the number and structure are species dependent
- Molars (12)
- Premolars (8)
- Canine (4)
- Incisors (8)

**Mouth (Oral Cavity)**



**Tongue** - composed of skeletal muscle that changes shape when contracted

- a fold of the mucous membrane attaches the tongue to the floor of the mouth
- upper surface is covered with **papillae** (house the taste buds - sweet, sour, bitter, or salty)

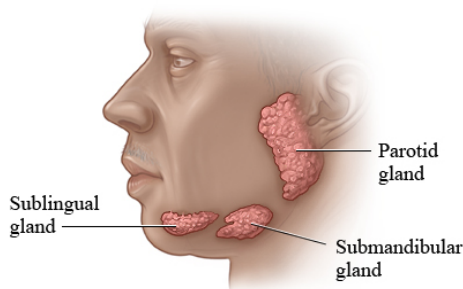
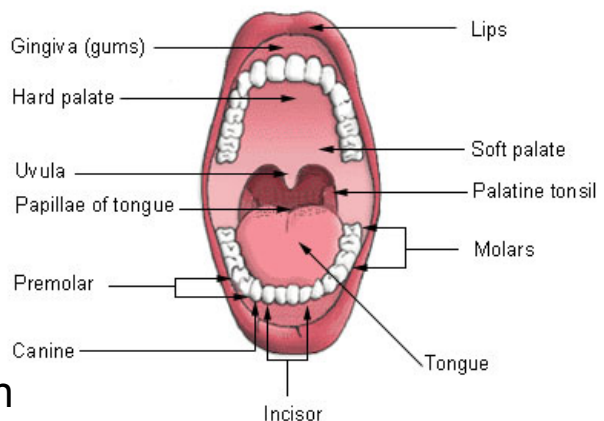
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## Uvula and Epiglottis

- help prevent food from entering the pharynx and nasal passage

**Salivary Glands** - three pairs which secrete saliva to aid in chemical digestion and lubrication

**Mouth (Oral Cavity)**



## The 3 Pairs of Salivary Glands

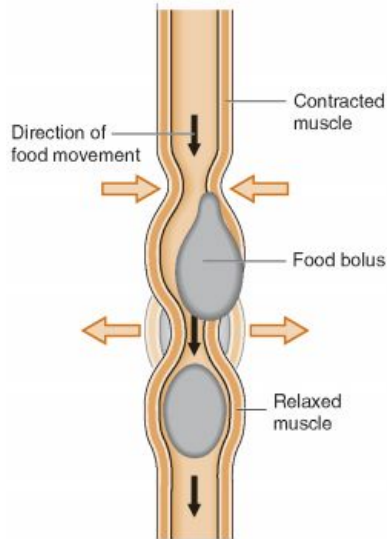
- Parotid Gland (largest)
- Submandibular Glands (aka submaxillary glands)
- Sublingual Glands (smallest)

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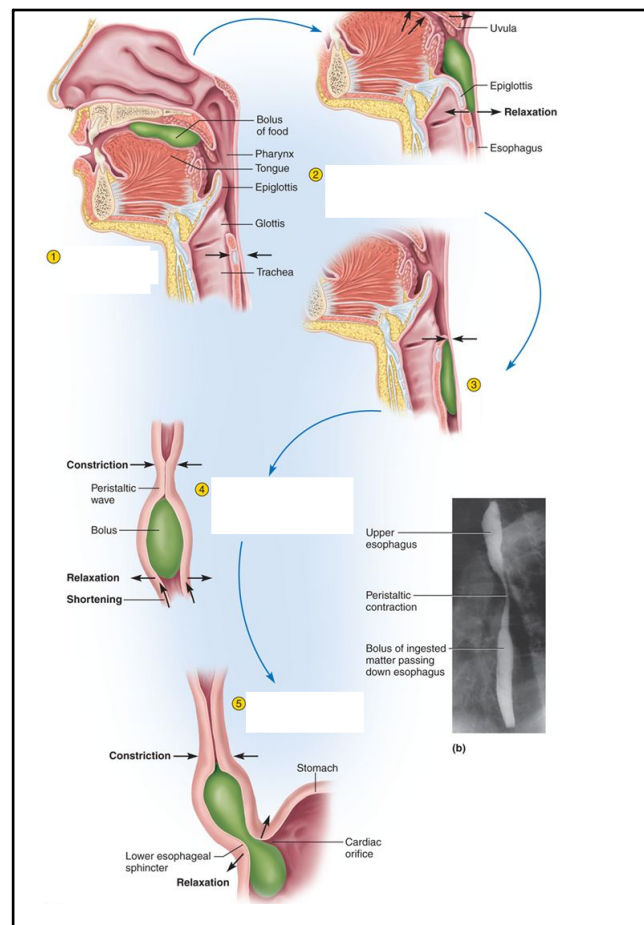
## The Esophagus or Gullet

- about 24 cm long and lined with circular and longitudinal muscles



- the muscles work in tandem to move food (bolus) through the process of **peristalsis** - movement of food through the digestive system using a wavelike contraction and relaxation of the circular and longitudinal muscles

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- glands at the back of the esophagus secrete mucin; a lubricant that helps the passage of the food
- the circular muscles at the bottom of the esophagus are thicker to give some involuntary control over the flow of food into or out of the stomach

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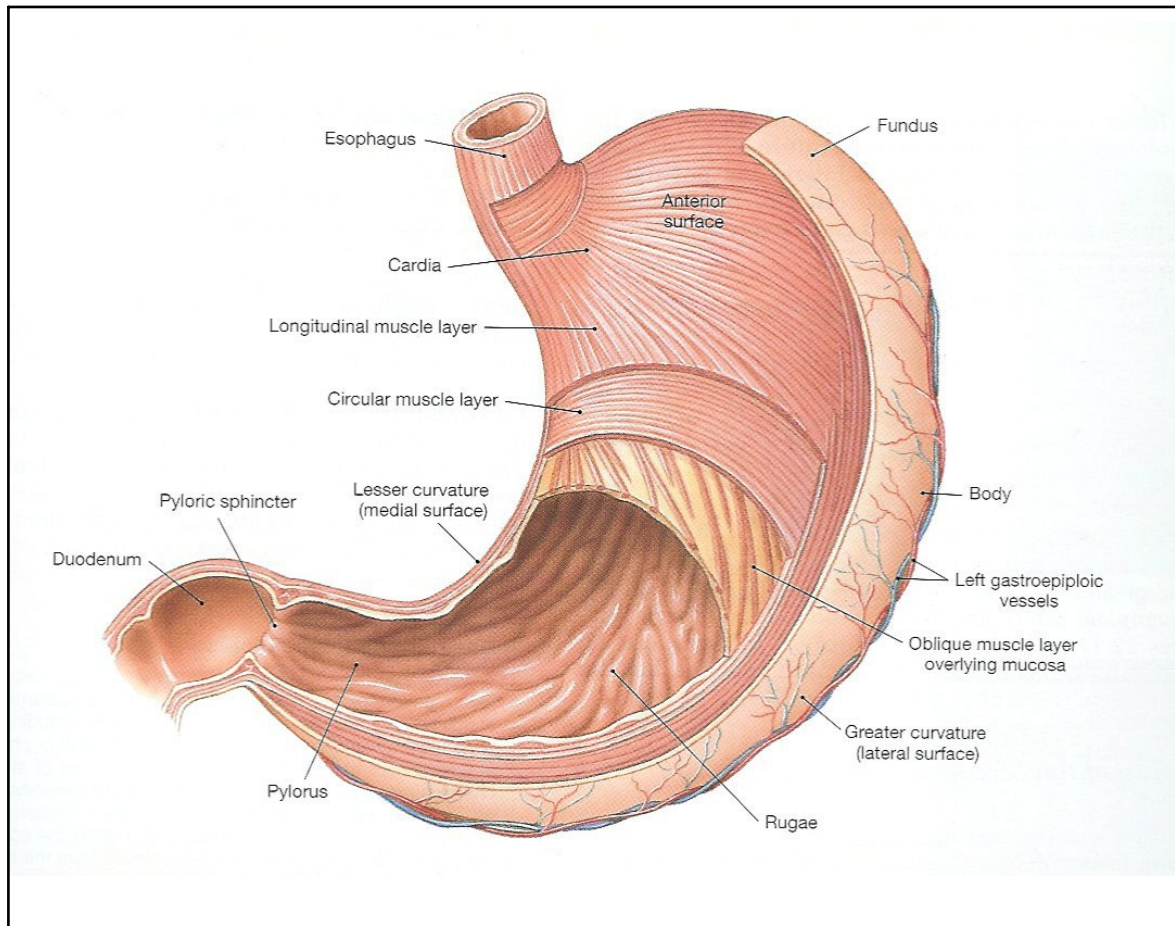
## The Stomach

- muscular J-shaped sac-like organ whose interior lining is packed with millions of gastric glands
- composed of three layers of muscles (circular, longitudinal, and oblique)
- the muscles work to break down the food and mix it with the gastric juices (strong acids and enzymes) to create chyme
- pyloric sphincter controls the flow of food leaving the stomach

Did you know:

- stomach growls are created from air and liquid being squished together.
- Burps are caused by air escaping your stomach and coming back up the esophagus

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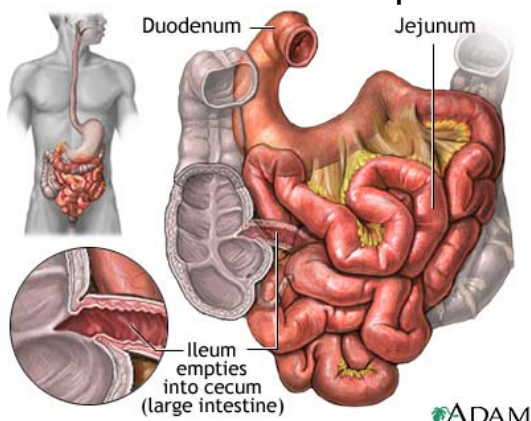


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## The Small Intestine

Divided into three regions:

- **Duodenum** - shortest and widest and shaped like a U
  - the pancreatic and bile ducts open into here
  - important site for further chemical breakdown



- has permanent, circular folds that increase the surface area of the intestine (increase the absorption area for nutrients as well)
- the folds contain villi (to increase absorption area) and between the villi are intestinal glands that secrete intestinal juices

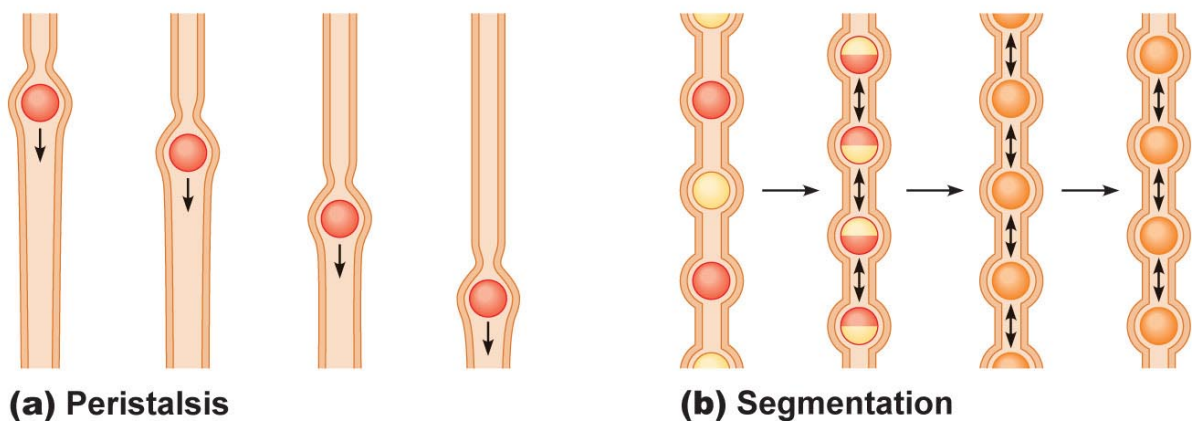
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- **Jejunum** - 2.5 m long and functions to breakdown proteins and carbohydrates
- **Ileum** - 3 m long and functions to absorb nutrients and push remaining undigested food into the large intestine

Most nutrients are absorbed by the end of the small intestine, leaving behind water, cellulose material that passes to the large intestine.

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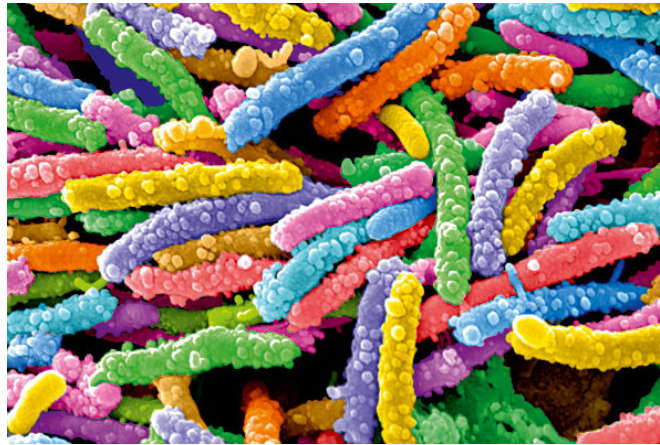
- food moves through the small intestine through a process called **rhythmical segmentation** - food is held in approximately the same part of the intestine while rhythmical contraction of the circular muscles squeeze it back and forth



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## Did you know?

Within our coiled muscular sausage-like length of human gut microbiologists have identified more than 5600 species of bugs and it's possible that the mix of bacteria, fungi and yeasts called microbiota are as unique to each individual as a fingerprint. Acquired from both the mother and the environment, by the time we're about two years old our microbial colonies are pretty stable. The first arrivals into our personal ecosystem are ingested by us as we are being born, others arrive in breast milk and from the environment.

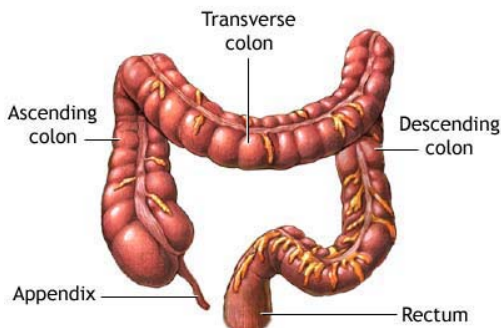
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## The Large Intestine

Is only about 1.5 m long and consists of the:

- **Caecum** - blind end of the large intestine
  - the appendix hangs suspended from the caecum

- **Colon** - the main portion of the large intestine

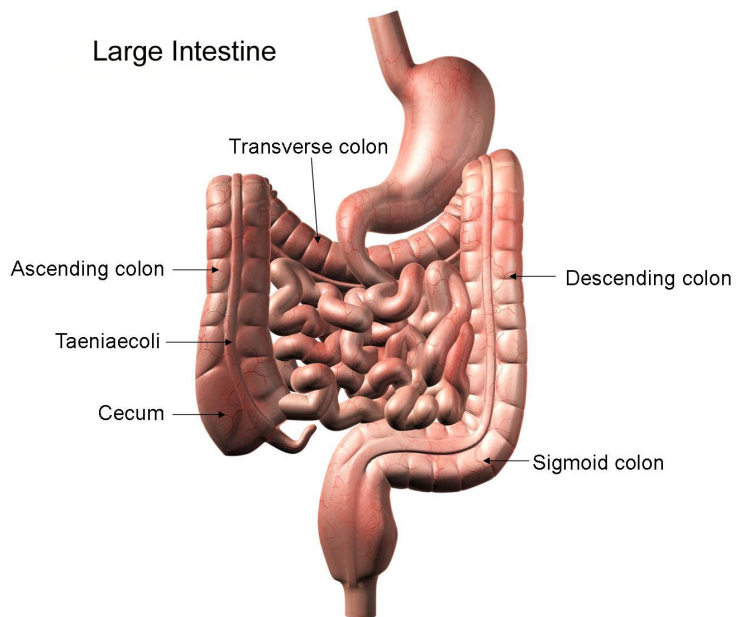


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- absorbs water and dissolved minerals
- intestinal bacteria help break down nutrients producing vitamins B-12, K and amino acids (gas is produced as a waste product)
- the indigestible material at the end is called feces

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- **Rectum and Anal Canal** - comprise the last 20 cm and leads to the anus - has ring of circular muscles called the anal sphincters that allow the body to control the elimination of waste to some extent.



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## Enzymes and Digestion

There are three classes of enzymes associated with digestion

- 1) carbohydrases - breakdown carbohydrates
- 2) lipases - breakdown lipids
- 3) proteinases - breakdown proteins

These enzymes work to speed up the process of hydrolysis - process of adding water to break bonds in large molecules

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Enzyme	Origin of Enzyme	Where Enzyme Acts/pH	Nutrient Molecule Digested	Products of Digestion
Salivary amylase	Salivary glands	Mouth/7	Starch, glycogen	Maltose (disaccharide)
Pancreatic amylase	Pancreas	Small intestine/8	Starch, glycogen	Maltose
Carbohydrates • sucrase • maltase • lactase	Small intestine	Small intestine/8	Sucrose Maltose Lactose	Glucose + fructose Glucose Glucose + galactose
Pancreatic lipase	Pancreas	Small intestine/8	Lipids	Fatty acids and glycerol
Proteases • pepsin • trypsin • chymotrypsin	Stomach Pancreas Pancreas	Stomach/1-2 Small intestine/8 Small intestine/8	Protein Small polypeptides Small polypeptides	Peptides Smaller peptides Smaller peptides
Peptidases	Pancreas and small intestine	Small intestine/8	Peptides	Smaller peptides and amino acids

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## Digestion Associated Organs

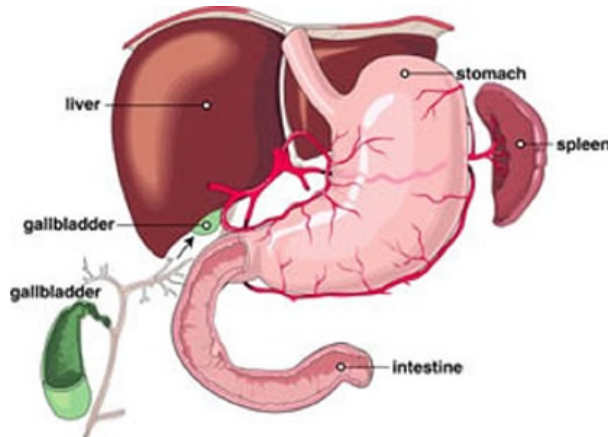
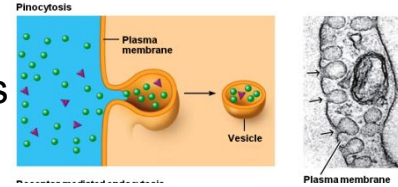
- The Liver
- The Pancreas
- The Gall Bladder

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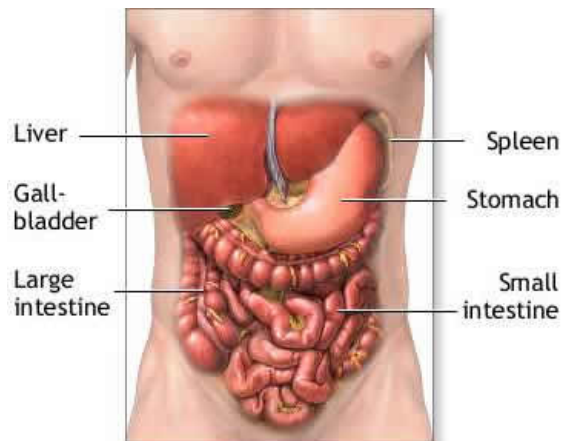
## The Liver

- responsible for producing bile salts that will be released into the small intestine to breakdown fat globules as needed.
- These broken down fat globules are engulfed by the villi through pinocytosis



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- Breaks down the old red blood corpuscles and uses the hemoglobin to make bile salts
- Collects monosaccharides that are in excess and converts them into glycogen
- Fat soluble vitamins (A, D, E, and K) are also stored here
- Also works to detoxify various poisons ingested with food and drink

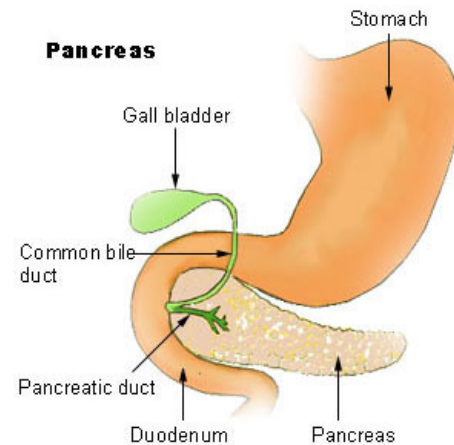


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## The Pancreas

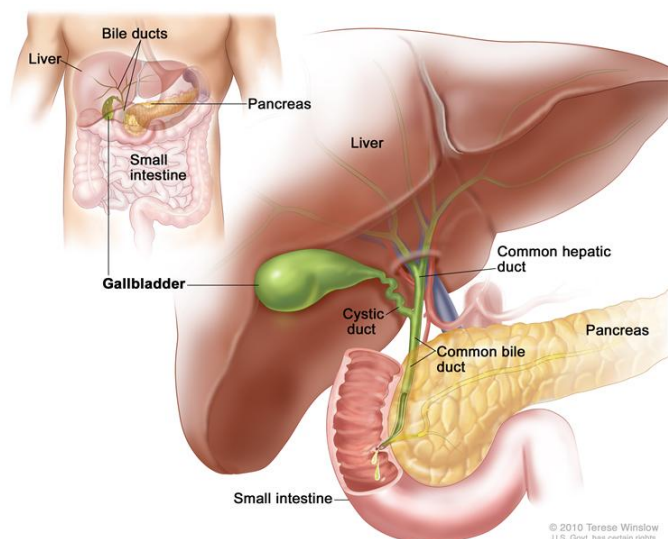
- source of several enzymes that act on carbohydrates, fats, and peptides
- produces a basic solution that changes the pH of chyme (from strongly acidic to weakly basic) after it enters the duodenum



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## The Gall Bladder

- serves as the storage warehouse for bile produced in the liver
- relaxing of the sphincter muscles allows the bile to enter the duodenum via the bile duct
- as lipids are absorbed by the intestine so are the components of the bile. The bile components return to the liver by the blood vessels to make more bile.



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## Learning Objective:

- 1) Describe eating and digestive disorders and their effect on the homeostasis of the system and the organism as a whole.

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## Digestive Disorders

1. Inflammatory Bowel Disease
2. Gallstones
3. Ulcers
4. Colitis
5. Anorexia nervosa
6. Bulimia nervosa

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